REPORT OF TWO SPECIES OF *THALASSIOSIRA* (BACILLARIOPHYCEAE): *T. ROTULA* MEUNIER AND *T. ANGUSTE-LINEATA* (A. SCHMIDT) FRYXELL *ET* HASLE, AS NEW TO NORTHERN CHILE.

Patricio RIVERA [1], Liliana HERRERA [2] and Hugo BARRALES [1]

[1] Department of Botany, University of Concepcion, P.O. Box 2407, Concepcion, Chile.
[2] Department of Marine Sciences, University Arturo Prat, P.O. Box 121, Iquique, Chile.

ABSTRACT — *Thalassiosira rotula* Meunier and *T. anguste-lineata* (A.Schmidt) Fryxell *et* Hasle are reported from samples collected in the north of Chile (20°48' S-70°11' W). *T. rotula* had not been previously reported from this area. The distribution of *T. anguste-lineata* in the South Pacific Ocean was known only from south of the 36°40' S. Using electron microscopy, the morphology of the frustules are described; in the cingulum of *T. anguste-lineata*, a double septate valvocopula was observed.

RÉSUMÉ - *Thalassiosira rotula* Meunier et *T. anguste-lineata* (A. Schmidt) Fryxell *et* Hasle ont été identifiés dans des échantillons recueillis au nord du Chili (20°48' S-70°11' W). *T. rotula* n'avait pas été signalé dans cette région; la distribution de *T. anguste-lineata* dans l'Océan Pacifique Sud-Est n'était connue qu'au sud de 36°40' S. Avec les techniques de la microscopie électronique la morphologie des frustules a pu être décrite, en particulier la structure du cingulum de *T. anguste-lineata* où une valvocopula cloisonée double a été observée.

KEY WORDS - Diatomophyceae, Bacillariophyceae, *Thalassiosira rotula*, *Thalassiosira anguste-lineata*, new record, distribution, Chile.

INTRODUCTION

The genus *Thalassiosira* Cleve is principally marine with species both neritic and oceanic. Together with *Chaetoceros*, *Coscinodiscus*, *Pseudonitzschia*, *Skeletonema* and "*Rhizosolenia*", *Thalassiosira* is one of the most common diatom genera in the marine coastal phytoplankton of Chile. *Thalassiosira* is characterized by the shape of its colonies, with cells joined by threads extruded from fultoportulae positioned in a definite pattern on the valve face. Although some species may be identified from waters mounts, most of them need to be cleaned and mounted in permanent resins to allow adequate observation of morphological features. Some of the most relevant characters for species identification include: number and arrangement of central and marginal

fultoportulae processes, length of process tubes, location and number of rimoportulae, number of areolae, number and morphology of the epicingulum bands, shape of the valve and of the valve mantle.

Thalassiosira species from East Pacific Chilean coastal waters were studied by Rivera (1981) using light and electron microscopy. In more than 150 samples collected between 18°S and 56°S the author described 24 taxa, many of which were new records for Chilean waters, and one new species. More recently, Rivera (1985) reports *T. weissflogii* again, extending its distribution and describing some variations in the structure of the cingulum.

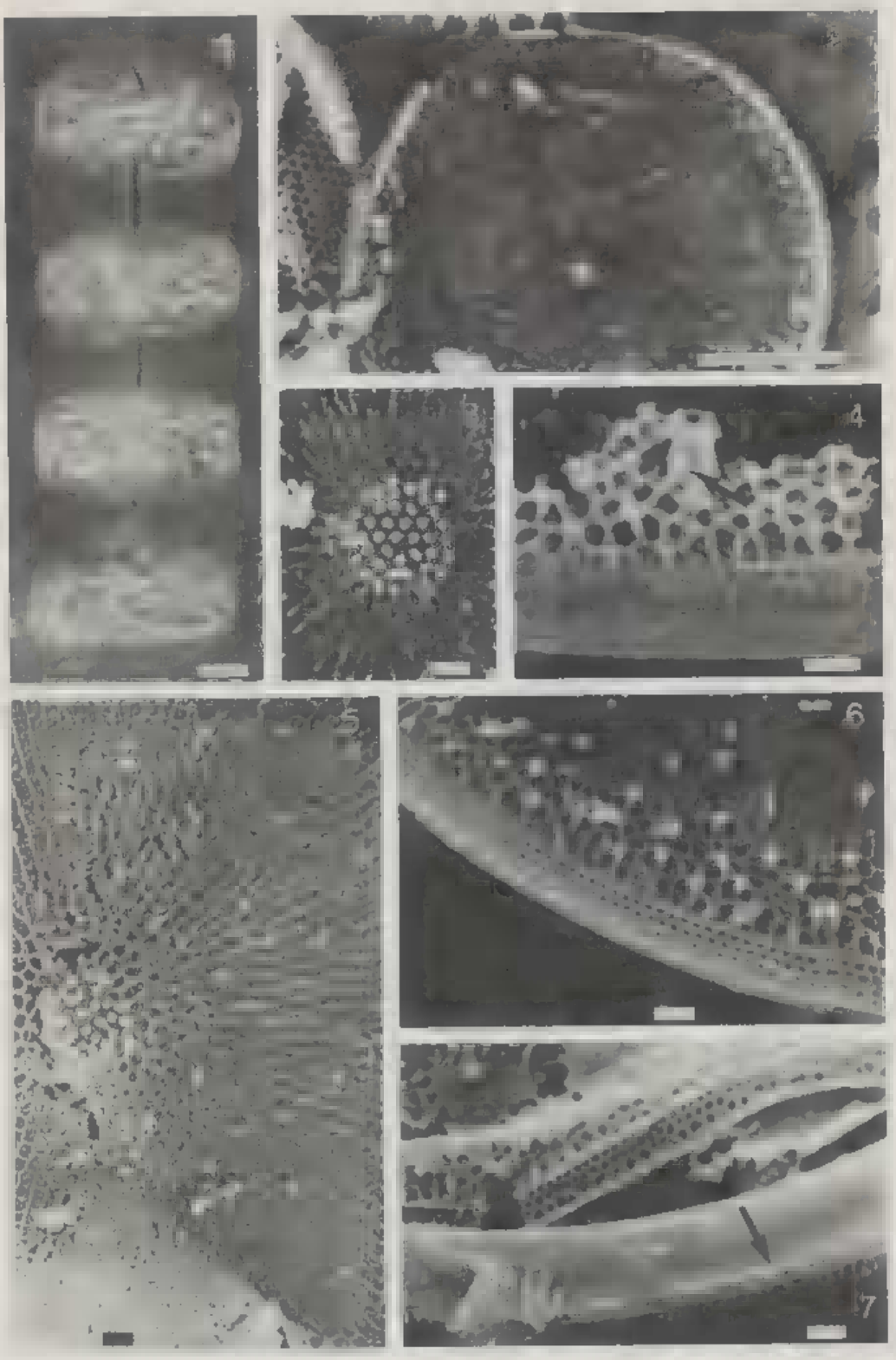
The study of field samples collected in northern Chile (Caleta Patache, 20°48′ S-70°11′ W) revealed the presence of two *Thalassiosira* species not previously reported from this area: *T. rotula* Meunier and *T. anguste-lineata* (A. Schmidt) Fryxell *et* Hasle. The morphology and distribution of *T. rotula* is very close to that of *T. gravida* Cleve. *T. anguste-lineata* was the dominant species in samples from Caleta Patache; previously its distribution along the Chilean coast was known only south of 36°40′ S. The present material provides better information about the structure of the cingulum of this species, in which ■ double septate valvocopula was observed.

MATERIALS AND METHODS

Fields samples collected in Caleta Patache (20°48′ S, 70°11′ W) during January 1994 and February 1995 were used in this study and are part of the Diatom Collection deposited at the Department of Botany, University of Concepcion, Chile. Samples were free of organic matter and mounted for light (LM), SEM and TEM microscopy, using the method described by Hasle & Fryxell (1970).

Critical point drying, as described by Anderson (1951), was used when necessary. The light microscope used was a Zeiss Photomicroscope III; the ETEC Autoscan U-1 scanning electron microscope and the JEOL 1200 EX II transmission electron microscope were used for electron microscopy. Terminology used is that suggested by Anonymous (1975) and Ross *et al.* (1979).

Fig. 1-7. *Thalassiosira rotula* Meunier. Fig. 1. LM. Chain formed by four cells. Scale bar = 10 µm. Fig. 2. LM. Many fultoportulae scattered on the valve surface. Scale bar = 10 µm. Fig. 3. SEM. Cluster of fultoportulae in the center of the valve. Scale bar = 1 µm. Fig. 4. SEM. External part of the rimoportula (arrow). Scale bar = 1 µm. Fig. 5. SEM. Valve covered by radial ribs; some areolae present in the center of the valve. Scale bar = 1 µm. Fig. 6. SEM. Three to four irregular rings of fultoportulae in the valve margin; valvocopula with horizontal rings of pores. Scale bar = 1 µm. Fig. 7. SEM. Areolate valvocopula and copula with a single row of abvalvar pores (arrow). Scale bar = 1 µm.



OBSERVATIONS

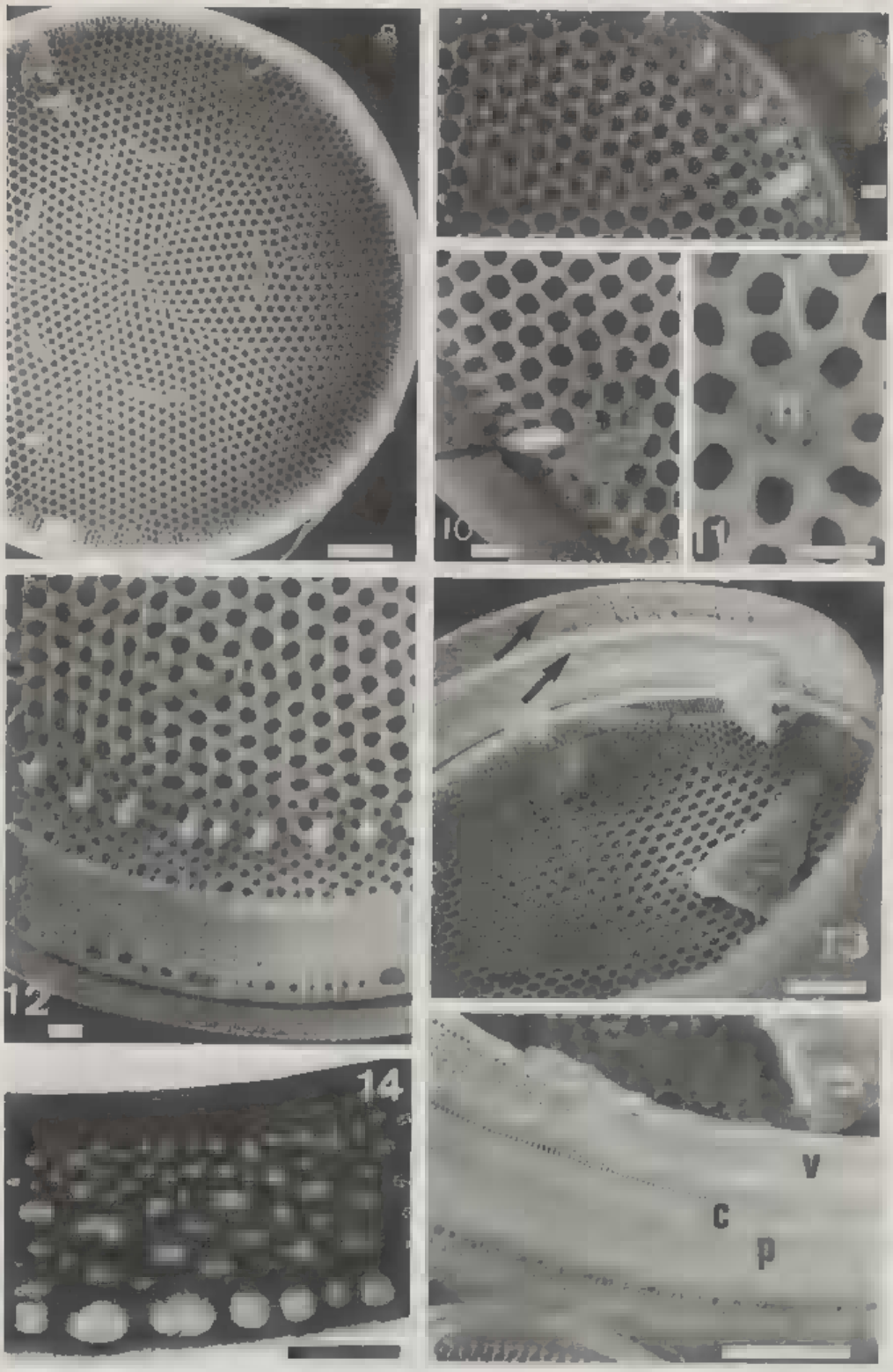
Thalassiosira rotula Meunier (Figs 1-7)
Meunier, 1910, p. 264, pl. 29, figs 67-70
Hustedt, 1930, pp. 326-328, fig. 163
Fryxell, 1975, p. 95, pl. XVI; figs. 13-14
Samples examined: DIAT-CONC 4642-4647, Caleta Patache, February 3rd, 1995.

The cells are disk-shaped in girdle view with slightly rounded edges and many small chromatophores (Fig. 1). The pervalvar axis is about 1/3 or less of the diameter of the cell. Chains formed by two to four cells were observed; the cells are united by many threads extruded from the center of the valves, appearing in water mounts as one thick thread, clearly visible in the moderately wide space existing between cells (Fig. 1). The valves are circular, 30-51 µm in diameter, flat, very slightly silicified. Most of the valve is covered by radial ribs; some areolae are present but only in the center, about 18 in 10 µm (Fig. 5), and in the marginal areas, ca. 20-22 in 10 µm (Fig.6). Many fultoportulae are scattered on the valve surface (Figs 2, 5), forming three to four irregular rings along the margin, 1 to 1.5 µm apart, (Fig. 6), while in the present material a cluster of 20-32 fultoportulae is located in the center of the valve (Figs 3, 5). One large rimoportulae is located in the valve margin between the third and fourth rings of fultoportulae (Fig. 4). In this species, the longest part of all these processes protudes out of the cell. The valvocopula has pores (30-33, exceptionally 38 in 10 µm) arranged in horizontal rings (Figs 4, 6, 7), sometimes forming more evident vertical lines; the pores of the last ring on the abvalvar side are a little bigger (Fig. 7). The second band (copula) is higher than the valcocopula and exhibits a single row of pores (33-34 in 10 µm) located on the abvalvar side (Fig. 7).

Thalassiosira anguste-lineata (A. Schmidt) Fryxell *et* Hasle (Figs 8-15)
Fryxell et Hasle, 1977, p. 73, figs 22-34
Rivera, 1981, p. 45, pls 5-7
Samples examined: DIAT-CONC 4639-4641, Caleta Patache, January 29, 1994; DIAT-CONC 4642-4647, February 3rd, 1995.

The structure of the valves of this species identified in samples collected from Chile was described by Rivera (1981), and the present observations confirm these findings. The valves are flat, 33-54 µm in diameter, and the areolae arranged in a

Fig. 8-15. *Thalassiosira anguste-lineata* (A. Schmidt) Fryxell *et* Hasle. Fig. 8. SEM. Internal view of valve surface. Scale bar = 5 µm. Fig. 9. SEM. External tubes of rimoportulae and fultoportulae. Scale bar = 1 µm. Fig. 10. SEM. Internal part of rimoportula (arrow). Scale bar = 1 µm. Fig. 11. SEM. One fultoportula located in the center of the valve. Scale bar = 1 µm. Fig. 12. SEM. Areolae on the valve face and mantle. External view of ornate valvocopula. Scale bar = 1 µm. Fig. 13. SEM. Internal view of cingulum; valvocopula appears to be doubly septate (arrow). Scale bar = 5 µm. Fig. 14. TEM. Detail of areolate valvocopula. Scale bar = 1 µm. Fig. 15. SEM. External view of cingulum showing an ornate valvocopula (v), a narrowed copula (c) and some hyaline pleurae (p). Scale bar = 5 µm.



fasciculated (Fig. 8), and sometimes rather linear pattern. There are 9-16 areolae on the valve face and 22-25 in 10 µm on the mantle. In the present material the fultoportulae form 5-6 groups halfway between the valve center and the margin, each arc with 2-7 strutted processes. A ring of fultoportulae, 4-6 (7) in 10 µm, is located on the edge of the mantle (Figs 9, 12). In some valves, one isolated fultoportula is located in the center of the valve (Fig. 11). One rimoportula located on the edge of the mantle (Fig. 9) has its internal aperture elongated and sessile (Fig. 10). The cingulum of the mature epitheca is composed of an ornate valvocopula, a narrowed copula and a variable number (3-4) of pleurae (Fig. 15). The valvocopula is areolate in structure; the areolae consist of vertical rows (34-50 in 10 µm). The cribra are evident in TEM micrographs (Fig. 14). The valvocopula appears to be doubly septate (Fig. 13), with large openings in one abvalvar row (Figs 12, 14-15). The copula has only one row of pores (47-52 in 10 µm), and the pleurae are hyaline (Fig. 15).

DISCUSSION

In the material collected in Caleta Patache, the specimens of *Thalassiosira rotula* were very scarce and the frustules were very slightly silicified; consequently the observation of all the morphologycal features was not possible.

T. rotula Meunier is so similar to *T. gravida*, a species described by Cleve in 1896, that Meunier himself stressed this fact. Both taxa have a similar process pattern (one marginal labiate process, a central cluster of fultoportulae and others scattered on the valve). According to Hasle (1976), the geographical distribution patterns of both species indicate that they may be modifications in the same species, and can only be discriminated by controlled culture experiments. Syvertsen (1977) published the results of his experiments on the effects of variation of temperature on valve morphology and degree of silicification, using strains of *T. rotula* and *T. gravida*. He demonstrated that all characteristics of the valve face structure changed from the typical of *T. rotula* at 17 °C to that typical of *T. gravida* at 3 °C: radial ribs on the valve to radial rows of areolae, disk-shaped cells to cylindrical cells, etc. However, he hesitated to reject *T. rotula* as a valid taxon, hoping to have more information from further investigations-.The presence of a septum in the copula, as described by Syvertsen (1977), could not be recognized in our material. However, the striking characteristic described by Meunier (1910) for *T. rotula*, namely a band "unevenly thickened", was apparent in one of the Chilean cells, and our observations correspond closely to the accepted description of the species.

Thalassiosira anguste-lineata was the dominant species in the material studied from Caleta Patache in 1994 and 1995 (10.475 cells l^{-1}), and chains of up to five cells, connnected by many threads, were observed. Water temperature varied from 14.6 °C to 15.6 °C, and the salinity was 34,6 10^{-3}. In this species, as in *T. rotula*, the processes are longer towards the outside of the cell, but the fultoportulae are shorter. A fact that was not previously reported by Rivera (1981), is that a few valves present a well structured central fultoportula. This characteristic was also suggested by Fryxell & Hasle (1977) for some cells. When not present, this is replaced by one areola usually a little bigger than the others. The external tube of the rimoportula is radially oriented, but its internal part is more tangentially positioned.

Knowledge of the structure of the mature epicingulum of *T. anguste-lineata* is very scarce, and Rivera (1981) gave some information about it. Thus, it is known that many *Thalassiosira* species with long internal tubes of the processes usually present bands with wide septa, but species with the longer portion of the fultoportulae towards the outside of the valve can also present narrow septa on its bands, as they do in *T. rotula* and *T. pacifica*. As far as we know, the presence of a double narrow septate band in *T. anguste-lineata*, as found in this study, was not yet described. The valvocopula of this species is very similar to that of *T. eccentrica*, as described by Fryxell *et al.* (1981).

More than 150 samples were studied by Rivera (1981) for the revision of the Chilean *Thalassiosira* species; however, *T. rotula* was not found in these samples nor in others examined later, and *T. anguste-lineata* had not been reported north of 36 °S. The sample collected in Caleta Patache in February 1995, containing *T. rotula*, registered water temperature of 15 °C and salinity 34.98 ‰.

According to our information, these taxa have not been reported off the coast of Peru, and it would appear that there exists only one previous record of *T. rotula* from the South Pacific Ocean. Avaria (1971) in his study on the phytoplankton from the Valparaiso Bay (33°02' S-71°38' W), collected between 1964 and 1966, reported this taxon (neither description nor illustration was given) as scarce during September, October 1964, February and April 1965 and May and June 1966.

T. rotula is a neritic species distributed in temperate and subtropical waters (Fryxell, 1975). According to the reports from the South Atlantic Ocean (Hasle 1976) the species presents a continuous distribution from about 60°N to 43°S.

Fryxell & Hasle (1977) consider *T. anguste-lineata* to be a littoral species from warm and cold waters. According to Rivera (1983), the species has been reported as living from 36°40' S to 55°10' S; however, it was also previously reported in the fossil deposits of Mejillones [23°06' S, 70°27' W] (Tempere & Peragallo, 1907) and Tiltil [33°05' S, 70°56' W] (Frenguelli, 1938). The knowledge of the marine diatom flora along the Chilean coast needs further observations. Many genera must be studied using modern techniques of microscopy to define more accurately the taxa that really exist in the area. This situation, for instance, takes on particular importance with the continuous occurrence of red tides in the south of the country, where many people, without adequate training, are repeatedly involved in phytoplankton monitoring.

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